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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication in the
Meat Packing Industry

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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Lubrication in the Meat Packing Industry

ABOUT the time that the meat industry was getting into its stride as a mechanized industry some wag was quoted as saying that the meat packers utilized every bit of the hog but the squeal. Nobody has ever found a use for this type of squeal. Another type of squeal, however, the squeal in machinery, has some value — it indicates that some part needs lubrication. The hog himself, along with the sheep and the steer, has furnished a most important contribution to lubrication in the form of refined animal fat which, when properly compounded with certain petroleum oils, takes the squeal out of some machinery.

While lubricant components are only a by-product of the meat industry, lubrication itself is one of the most important details in maintenance of meat packing and handling machinery. It has achieved this importance because so much of the machinery must operate exposed to moisture or in refrigerated rooms, requiring lubrication with water-resistant products or those capable of functioning under the prevailing cold conditions which may be well below zero Fahrenheit.

Controlled lubrication is of vital importance. Under the supervision of an experienced lubrication engineer, who is equally as familiar with lubricant characteristics as he is with machinery requirements, controlled lubrication contributes amazingly to low maintenance costs and power economy.

IN THIS discussion of meat and its passage through a modern packing plant, most emphasis is placed upon the machines involved as these are of chief interest to those who must lubricate them, maintain them and keep them running. It is hoped that we will have presented this article on meat packing machinery in such a way that it will help the operators to increase their already extensive knowledge of effective lubrication.

Perhaps we will have presented some of the more interesting highlights of the various processes so that those concerned with other industries also will discover that the best way to keep from having lubrication problems is to correct the cause before the effect occurs.

REFRIGERATION

The meat industry furnished one of the major reasons why mechanized refrigeration had to be developed. Until then the good old-fashioned way of utilizing ice cut from frozen ponds or rivers in winter was the only alternative for storage of meat in insulated ice houses. Engineering talent solved the problem. The answer was obtained toward the latter part of the 19th century, when the technique of compression was applied to certain chemicals — notably ammonia — which function as refrigerants by their expansion after they have been properly compressed and liquified or condensed.

Meat packing refrigeration can be direct or indirect. In the former, the refrigerant is used directly to manufacture ice or cool meat storage compartments by expansion in suitable coils located therein. Indirect refrigeration involves preliminary cooling of air by circulating it over brine coils or through brine sprays in a separate compartment or deck.

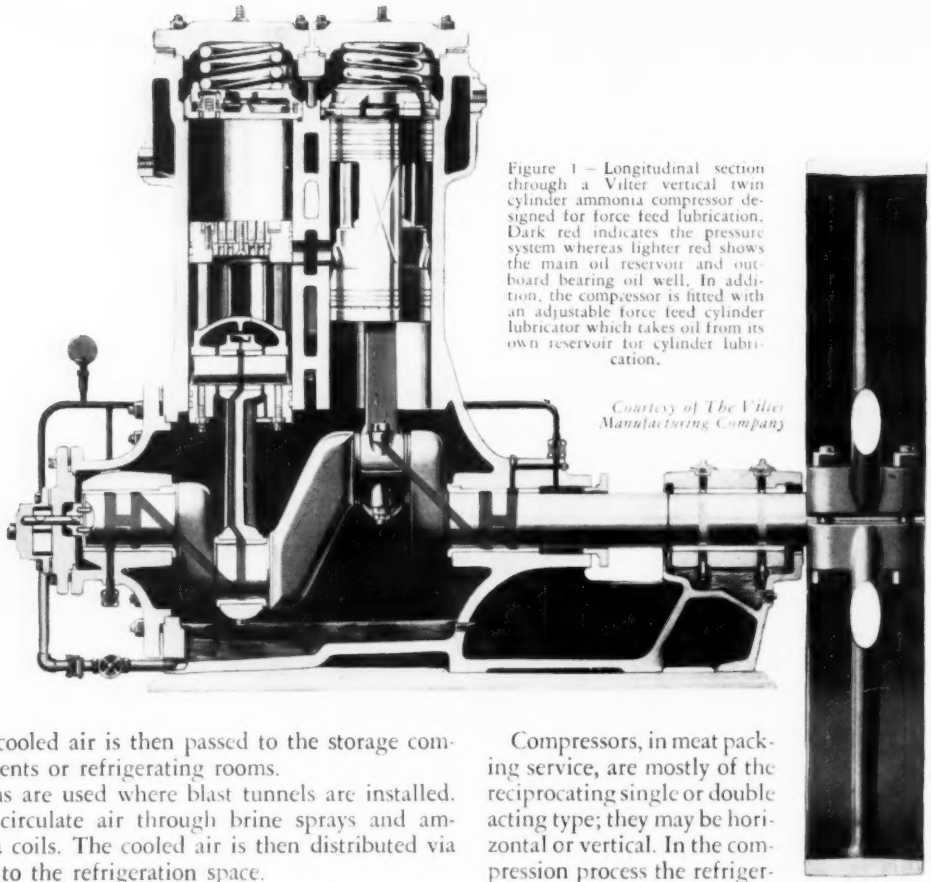


Figure 1 – Longitudinal section through a Vilter vertical twin cylinder ammonia compressor designed for force feed lubrication. Dark red indicates the pressure system whereas lighter red shows the main oil reservoir and outboard bearing oil well. In addition, the compressor is fitted with an adjustable force feed cylinder lubricator which takes oil from its own reservoir for cylinder lubrication.

Courtesy of The Vilter Manufacturing Company

This cooled air is then passed to the storage compartments or refrigerating rooms.

Fans are used where blast tunnels are installed. Fans circulate air through brine sprays and ammonia coils. The cooled air is then distributed via ducts to the refrigeration space.

The heaviest refrigeration load is developed in carcass coolers where the heat of the freshly killed animals must be reduced before the carcasses can be cut. This is done by overnight chilling; the temperature of hogs, for example, must be reduced from around 90° F. to 32-34° F.

How Refrigeration Works

Ammonia is the most widely used refrigerant. The system must be tightly sealed to prevent leakage.

As a preliminary to discussion of refrigeration machinery, it is of interest to review the principles involved. There are two stages:

1. Evaporation and expansion of the refrigerant, whereby heat is absorbed from the surroundings, and,
2. Compression and condensation, whereby the heat is in turn abstracted from the refrigerant and the latter converted to liquid form once again.

In a compression refrigeration set-up the system includes the evaporator, compressor, oil separator, condenser, receiver, and expansion valve.

Compressors, in meat packing service, are mostly of the reciprocating single or double acting type; they may be horizontal or vertical. In the compression process the refrigerant or cooling agent is recovered after each expansion by means of mechanical compression. With certain variations in construction and arrangement of equipment, the compression process is adaptable to any one of the refrigerants in accepted usage today.

In operation, the gaseous refrigerant in a compression system must be sufficiently compressed and cooled to convert it to liquid form. Under compression alone, it will still remain as a gas since pressure raises the temperature above the liquefaction point. Some form of condenser must therefore be used.

Prior to condensation, however, the gas is usually passed through a suitable oil separator or trap in order to free it of any excess lubricant. From the oil separator the hot gas then passes to the condenser, where its temperature is reduced by means of air or cold circulating water to convert it to liquid form. It is then capable of serving as a cooling medium.

Cooling is brought about by reducing the pressure. Some systems pass the refrigerant through an expansion or regulating valve to the evaporating

side of the system. Here, by virtue of a considerable drop in pressure, it evaporates and is able to take up heat. In so doing, it absorbs heat from the surroundings. It is then returned to the compressor to repeat the cycle.

Some packers use the absorption system involving a heat cycle instead of a compression cycle to develop low temperature.

Selection of Lubricants

Lubricants for meat packing refrigeration machinery must be selected with due regard for the service involved and the operating conditions that may prevail.

Temperatures in packing house refrigeration will vary. Meats in cold storage are held at around 10° F. When sharp freezing is to be done on shelf coils, the temperature of the coils is run down to around −20° F. Quick freezing in the meat industry is done at around −35° F. with the tendency today to go even lower.

Lubrication of refrigerating machinery is unique in that the action and effects of the lubricants upon parts not requiring lubrication must be considered along with the lubricating ability. To overlook or disregard the importance of such factors as the method of lubrication, the temperature in the expansion or refrigerating coils, the mechanical condition of the compressor, and the location, type and efficiency of the oil separator may frequently lead to marked increase in maintenance costs and reduction in capacity.

Oil congealed in any part of the cooling system will tend to reduce refrigerating efficiency if it becomes so sluggish under the low temperatures involved as to form an interior lining in the expansion coils; this will affect the heat transfer. Oil in the condenser will affect the head pressure. An oil for refrigerating machinery lubrication must, therefore, remain fluid at the lowest temperature to which it may be subjected during the operation. These temperatures will be encountered in the expansion or refrigerating side of the system, or, in other words, beyond the expansion valve. There are many oils which, by virtue of their base and degree of refinement, will not be able to withstand lower temperatures without congealing to a certain extent, depending upon the wax content.

When congealment occurs a film of oil will be deposited on the inner surface of the refrigerating piping to form an insulating layer which will prevent proper abstraction of heat from the compartment or medium which is to be cooled. If this is allowed to continue it is evident that the refrigerating capacity of the system will be reduced and ultimately it will be necessary to clean out these congealed oil deposits.

Types of Lubricants

For ammonia compressor service where the temperature in the refrigerating coil is below 5° F. a straight mineral filtered low pour test oil having a viscosity around 150 seconds Saybolt at 100° F. will be necessary. Above this temperature, however, an oil of somewhat higher viscosity, i.e. 200 to 500 seconds Saybolt, depending upon the recommendation of the compressor builder, will give satisfactory results. A highly refined straight distilled mineral oil should be used to assure that these requirements are met. Such oils will lubricate an ammonia compressor effectively with a minimum of vaporization, under the usual operation conditions which prevail in meat packing service. The lower the viscosity the lower the pour test will be for oils of the same degree of refinement

Lubricating Systems

Splash and pressure lubrication are used in industrial refrigerating compressors. The latter is suited for the lubrication of both vertical and horizontal machines. The former, however, is more adaptable to the small size vertical compressor. The lubricating system must be considered when deciding upon the oil viscosity; a pressure lubrication system can often handle a higher viscosity oil than a splash system.

Pressure Systems

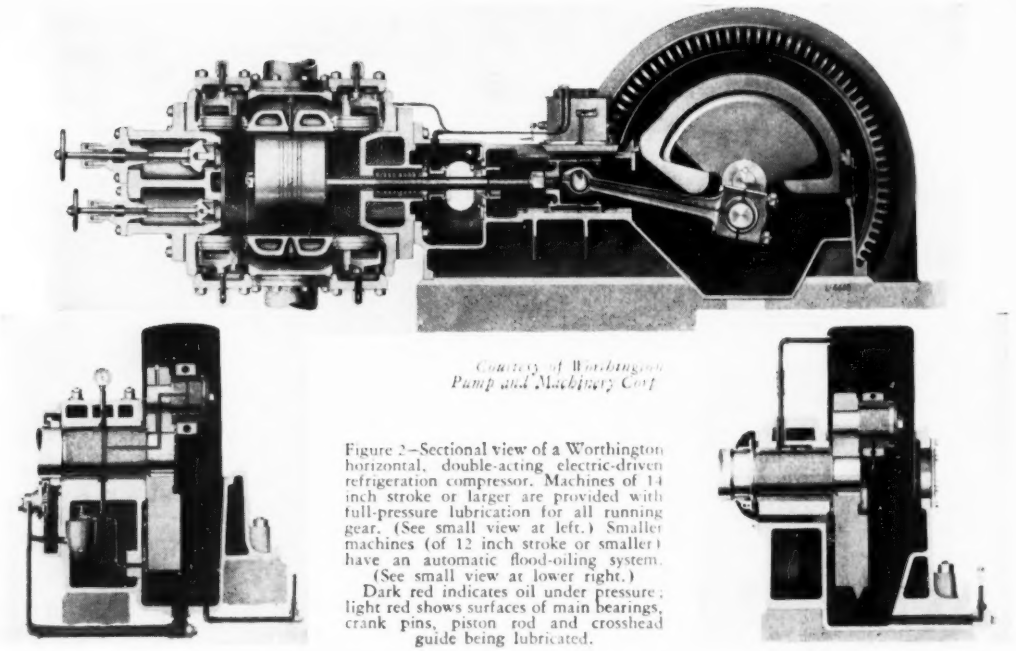
Where larger types of vertical or horizontal refrigerating machines are involved, pressure lubrication is used with marked success. Pressure lubrication assures of accurate control of the amount of oil delivered to cylinder walls and compressor bearings.

Mechanical Force Feed Lubricators

External lubricators of this type are extensively used to serve the compressor cylinders. Excellent economy will be attained by regulating such lubricators as recommended by the compressor builders, so that just enough oil is delivered to maintain the requisite lubricating films.

Many of such machines are designed for individual lubrication of the internal and external parts. In other words, a mechanical lubricator with two or more outlets is used for cylinder and stuffing box service, and an independent gravity or mechanical pressure circulating system for all external bearings.

Mechanical force feed lubricators are especially adapted to cylinder and rod lubrication via the oil lantern, or oil recess within the piston rod stuffing box. By properly constructing a stuffing box with a lead to come from the lubricator, it is possible to



Courtesy of Worthington Pump and Machinery Corp.

Figure 2—Sectional view of a Worthington horizontal, double-acting electric-driven refrigeration compressor. Machines of 14 inch stroke or larger are provided with full-pressure lubrication for all running gear. (See small view at left.) Smaller machines (of 12 inch stroke or smaller) have an automatic flood-oiling system. (See small view at lower right.) Dark red indicates oil under pressure; light red shows surfaces of main bearings, crank pins, piston rod and crosshead guide being lubricated.

operate the piston rod continually through a ring of oil. In this way, effective rod lubrication, as well as sealing against pressure, are maintained.

Oil Separator Operation

Wherever an excess of oil may find its way to the evaporating or cooling side of a refrigerating system, certain detriments will be involved. It is interesting to note how an oil separator functions to prevent this.

A separator is designed to remove any particles of oil from the refrigerant while it is in vapor form, after it has left the compressor. The larger the oil particles, the more effective will be the separator. It should, therefore, be located at a sufficient distance away from the compressor to permit of adequate precipitation of the oil within the refrigerant gas.

The capacity of any separator should be ample so that the velocity of the gas passing through will not be too high, for it can become overloaded if an excessive amount of oil is fed to the compressor.

Sealing the Stuffing Box

Suitable stuffing box seals and properly lubricated piston rods are very important with ammonia compressors. Ammonia exerts a corrosive action upon brass, copper and bronze. Stuffing boxes for such service are, therefore, usually built of cast iron or steel, using metallic, fabric material, asbestos, or rubber packing.

STEAM

Steam is required in the packing industry for heating purposes in rendering and processing edible and non-edible fats; it is also used for sterilization of certain of the containers, conveyer hooks, trolley wheels and cutting knives, and for heating the large volumes of hot water which the packing house must use. As an operating medium it us used for driving steam turbines, reciprocating pumps or engine driven compressors where the heat balance between electricity and steam favors the latter.

Normal pressure steam of around 125 to 175 pounds pressure, having a temperature of around 340 to 370° F., is used in most plants. Others require steam up to around 265 pounds pressure where they utilize steam of this nature to bring up the temperature of shortening and edible oils during the deodorizing process to improve flavor and taste.

Steam which is used for other types of process heating, however, must have its pressure reduced. Various pressures are used according to the product. For example, 50-pound steam is used for wet rendering; 80-pound steam for dry rendering; 40-pound steam for stock food dryers; 5-pound steam for hot water heating.

Steam cylinder lubrication, therefore, becomes one of the responsibilities of the master mechanic or power engineer. The normal steam pressures and temperatures that prevail present no problem from a heat point of view; the fact that lengthy steam lines are sometimes involved, however, can

result in considerable line condensation. This means that the steam may have a high moisture content when it reaches some of the pumps. A well refined, compounded steam cylinder oil, therefore, is necessary, to assure that sufficient emulsification will develop to form a water resistant lubricating film on cylinder walls and valve seats.

The Need for Compounding

The meat packers have contributed to the science of lubrication by preparing the necessary fats which are used in so many of the modern steam cylinder oils, i.e., prime lard oil and acidless tallow. Unless good fats are used the stability of the resultant compounded oil is affected if the fatty components turn rancid. Then an acid reaction may be promoted which will have a corrosive effect on some machine parts.

In steam engine, pump or compressor service where reciprocating pistons and valves are involved, a steam cylinder oil must lubricate every sliding surface which is either in direct contact with the steam or subject to its pressure and temperature.

Engine design as it involves steam valves, valve rods, slide valve seats, cylinder walls, pistons, piston rings, piston rods and throttle valves, must, therefore, be carefully considered. These parts are not always subject to the same pressure and temperature conditions, yet one oil must serve throughout and, therefore, it must be sufficiently flexible in operation to produce efficient lubrication wherever necessary.

Nature of Cylinder Oil

Steam cylinder oils must be of comparatively heavy body and have a particularly adhesive characteristic in order to insure the maintenance of a lubricating film which will resist the wearing or scraping effects of the average valve and piston, and washing off by steam.

Viscosity or body is attainable by suitable refining; adhesiveness by judicious treatment of the cylinder stock and the addition of certain fixed or fatty animal oils. As a general rule, it will be essential to use an oil having a viscosity range of between approximately 130 and 190 seconds Saybolt at 210° F., according to the steam pressure and temperature involved, the type of steam valves and the means of application available.

Steam Distributes the Lubricant

The most efficient way of getting the lubricating oil to all desired points is to make use of the steam itself, which reaches all moving elements inside of the valve chambers and cylinders with the possible exception of parts of certain types of Corliss valves.

If the oil is divided into minute globules and intimately mixed with steam only a very small quantity is required, and the degree of success in the atomization of the oil will control both the efficiency of lubrication of the parts and the quantity necessary.

The more complete the atomization and the more thoroughly saturated all portions of the steam, the better will be the lubrication of all of the cylinder parts, and the more economical the consumption of oil. The degree of atomization of the oil is influenced by the condition of the steam, the point of introduction of the oil, the velocity of the steam, and the character of the oil.

Moisture Requires Compounding

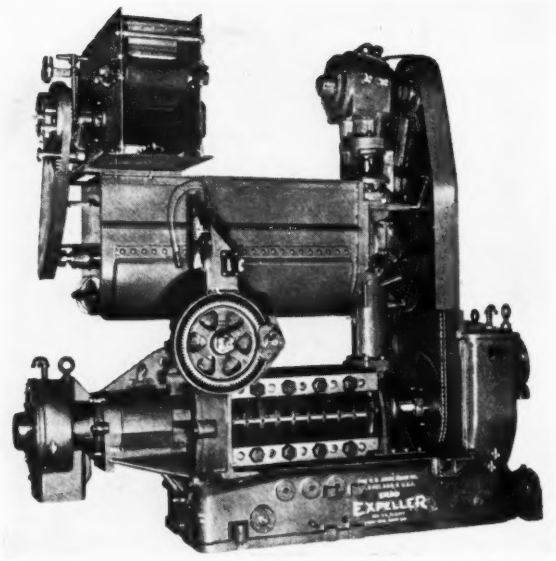
Steam will always contain a certain percentage of moisture unless it is superheated to a sufficient extent to counteract any line and cylinder condensation, which may be caused by the cooling effect of the piping or cylinder walls, and the expenditure of heat by the expansion stroke. The presence of moisture in steam will usually result in a film of straight mineral lubricating oil being rapidly washed off from the cylinder walls and other surfaces with which the steam comes in contact. Therefore, to secure proper lubrication under wet steam conditions, it is necessary to either increase the rate of flow of a straight mineral oil, or else substitute an oil which contains a certain percentage of fatty compound, such as lard oil or tallow.

Compounding develops an emulsion through reaction of the compound with the moisture in the steam. The resultant lubricating film thus has a high affinity for the cylinder walls and other wearing surfaces and is very resistant to the washing action of the water in the steam. The greater the percentage of moisture in the steam the higher should be the fatty compound content of the lubricant though six per cent is the usual maximum.

An excessive amount of fatty compound, beyond that necessary to form the requisite emulsion, will not improve the lubricating value of the oil. In fact, it may even be an objection, especially under continued exposure to high temperatures, on account of the tendency that animal fats have to decompose and form carbon and corrosive acids.

It is best to use only just enough compound to conform to the moisture conditions of the steam and maintain a suitable film of oil on the cylinder walls. In other words; reduce the quantity of compound and improve the quality.

This is especially important where the exhaust steam is to be used for feed water heating or in process work of any nature. Under such conditions it is more important than ever to observe caution in selecting and using steam cylinder lubricants.



Courtesy of The V. D. Anderson Company

Figure 3 — Front view of the Anderson Duo Crackling Expeller.

Where Compounding Is a Detriment

The property which causes compounded oils to unite with water to form emulsions in the cylinders also prevents ready separation from water in condensed steam; likewise, the more completely the oil is atomized the more difficulty will it have in separating from water. Obviously this may cause trouble where the condensate is used for makeup or led to open feed water heaters.

Oil emulsions in a boiler combine with the boiler compounds to cause foaming, or with the boiler impurities to produce a coating over the tubes. This coating seems to form more readily over clean tubes than dirty ones. A very thin layer of oily sludge over a tube or shell surface will so insulate it that there is not only a large loss in heat efficiency, but the rise in temperature of the metal may be so excessive as to cause burning out or explosion of the boiler.

COMPRESSED AIR

Air compressors are required in the packing plant power house, to furnish compressed air for operating air lifts, for cooler door openers, for sprinkler systems, sausage stuffing machines, branding or applying inspection labels and for air tools or small air hoists used in plant construction or maintenance work.

Horizontal two-stage reciprocating compressors, either with or without after coolers are used. Air is compressed to around 100 pounds pressure.

While only one or two compressors may be required to furnish the amount of air used, continued operation of these machines is most important because if failure of the air supply makes it impossible to operate air lifts or cooler doors, the entire routine of the plant is interrupted. Plant operations and cooling of the carcasses prior to cutting is carefully scheduled; any need to resort to hand hoists or opening cooler doors by hand would require reassignment of labor and slow down production.

The Importance of Lubrication

So the plant engineers take great care of their compressors and regard lubrication as probably the most important adjunct to successful operation. It is not much of a problem to lubricate a reciprocating type air compressor regardless of whether it is motor or steam driven, provided the lubricating oil for the air cylinders is a highly refined compressor oil and the lubricator is properly adjusted to feed the right amount of oil. To accomplish this, mechanical force feed lubricators driven off the reciprocating mechanism of the compressor are used. Only two or three drops of the right oil per minute are needed to keep the valves, pistons and cylinder walls properly lubricated. Too much oil would mean carry-over into the receiver and air lines and ultimately might cause accumulations of foreign matter (if non-filtered air is used) in restricted parts of the distributing system.

The Oil

A good air compressor oil should be of medium body, having a viscosity of from 200 to 350 seconds Saybolt Universal at 100° F. As air becomes heated when compressed, the oil must be able to withstand heat without excessive formation of carbon deposits. The theoretical cylinder temperature at the end of the piston stroke when air is compressed in a two-stage machine to around 100 pounds pressure is around 240 to 250° F. Intercooling, however, reduces this air temperature, so temperature will have no serious effect on a properly refined compressor oil.

Along with the viscosity the carbon residue test on the oil is of significance. A closely refined compressor oil will show a very low carbon residue test, i.e., 0.04% maximum. This means that when the oil is entirely distilled that the amount of carbon residue left will be practically negligible. A compressor oil of very low carbon residue content insures a clean system even though the engineer, because of some particular condition of the compressor, considers it necessary to feed more oil to his air cylinders than is usually necessary.

HOG DEHAIRING

Hog carcasses must be dehaired before they are eviscerated and sent to the carcass coolers. Dehair-

ing is done in a special machine in which the carcass is rolled over and over on a series of U-bars and passed through the machine by the scraping action of beaters. These beaters are made of flexible rubber or fabric material. One end is fastened to a wheel, the other has a steel blade attached which scrapes over the carcass as the wheel turns. A number of beaters are attached to each wheel close to the hub; the wheels are fastened to a rotating shaft, which is carried on plain babbitted bearings in the U-bars.

Another type of machine suspends the hog by the hind legs. The carcass turns as it goes through the machine; as it turns beaters similar to those in the U-bar machine scrape off the hair.

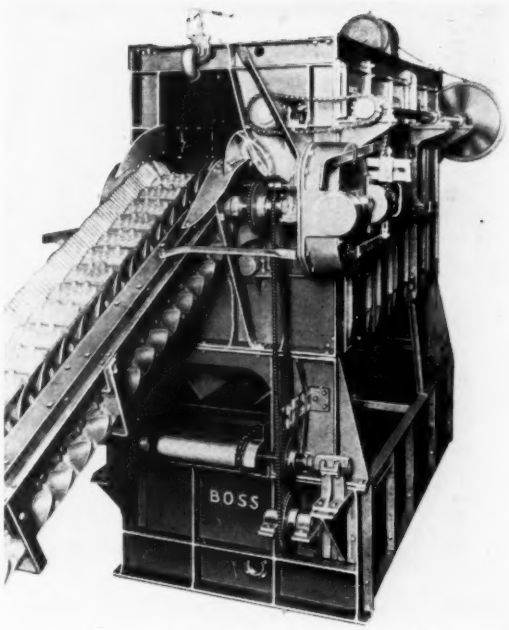
While the hog carcasses are being dehaired, they are subjected to hot water spray (temperature around 130 to 140° F.). Exposure of many of the shaft bearings in a dehairing machine to water wash makes bearing lubrication quite a problem. Some packers have devised gravity oiling systems in order to best protect these bearings. Others use mechanical force feed oilers to assure that the bearings are well lubricated. Sleeve type bearings are largely involved, requiring a medium viscosity machine oil where positive lubrication can be maintained.

CUTTING AND PROCESSING

Meat products are processed according to how they are to be used or sold. Beef, is sold in sides or quarters and usually goes direct to market. Lamb is sold whole. Hogs are usually cut and sold as fresh pork, or processed. Hams and sides of bacon are smoked. Cuttings or trimmings are ground for sausage meat or canning. Sausage meat, after spicing, may be packed as patties or stuffed into casings by sausage stuffing machines. Bacon, in turn, after smoking is sometimes pressed to shape in an air-pressure or hydraulic operated press and then run through slicing machinery, or sold in slab form.

The fats from all of these animals are rendered or cooked down to make edible or non-edible (industrial) fats. Beef and mutton tallows may go to industrial fats or edible shortenings and oleo oils. The Petroleum Industry is one of the large consumers of tallow as a component of cylinder oils and lubricating greases. Pork fats, have an equally divided usage. The edible variety go to lard; the non-edible fats (lard oils) also go very largely to the Petroleum Industry for compounding with cutting oils or lubricating greases. Others go to soap manufacturers.

The residue of the carcasses, other than edible parts, and hides and hoofs, go to other inedible products such as industrial oils, soaps, glycerine, stock feed and fertilizer. The latter require drying, expelling of non-edible oils, grinding, screening and packing.



Courtesy of The Cincinnati Butcher's Supply Company

Figure 4 — The Boss Universal Dehairer showing features of the conveying and driving mechanisms.

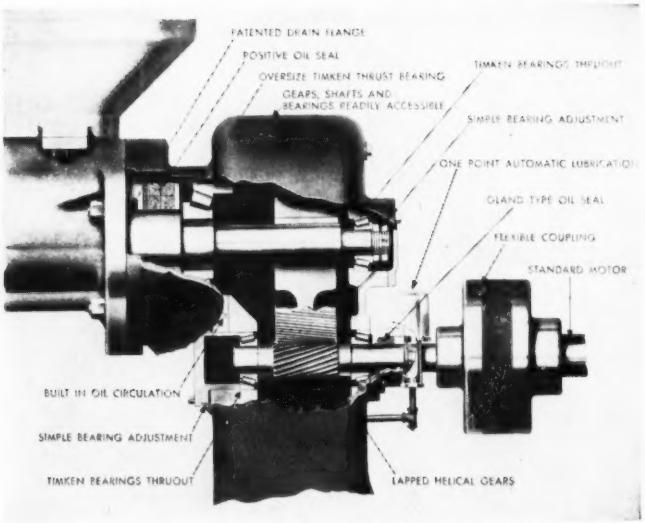
Cutting

Carcass cutting is done after suitable overnight cooling. Band saws, similar to those used in a woodworking shop, are used; portable electric saws, revolving at high speed and mounted on anti-friction bearings are also used. Circular revolving knives are used for intermediate cutting and heavy trimming purposes. In addition, there are the ham skinning machines, which work on the principle of a planer.

Anti-friction bearings are favored on modern meat cutting machinery, since they can be most tightly sealed and built resistant to water wash. One of the chief headaches of the master mechanic is to keep bearings lubricated in the face of wash-down procedure when high pressure hoses are played all over the machines. This also applies to electric motors. In such service, the ball or roller bearing holds its lubricant best, especially if the latter is specifically prepared for these bearings, see "Bearing Lubricants" pp 34-36.

The Tank House

Here meat products, which are to go to stock or poultry feed, are processed to render out the fats. This involves cooking kettles; or melters which are cylindrical steam heated tanks, in which a stirring paddle is rotated. The paddle shaft is mounted on grease lubricated plain or roller type bearings being driven by an electric motor through speed reducers,



Courtesy of John E. Smith's Sons Company

Figure 8 — Bearing mechanism of the Smith Grinder.

gears or chain connections. To facilitate cooking, some packers pull a certain amount of vacuum on the cookers by means of a vacuum header and vacuum pumps.

Expellers or presses are used to press out the remaining oil and to dry the residue sufficiently so that it can be removed for charging to the grinders, which grind it down to about 10 mesh fineness. Expellers are subject to very severe service and require care to be sure that lubrication is properly maintained.

Smoking

There is no lubrication involved in the smokehouse unless the traveling type is used in which the bearings are exposed to considerable heat. The smoke is obtained by burning hardwood sawdust. Temperature and moisture conditions must be just right for best quality hams and sausage. Air conditioned smoke houses in which the humidity and temperature are closely controlled are recent developments. They involve air operated controls and pumps.

Sausage Stuffing and Linking

The sausage stuffing and linking machines are among the most intricate mechanisms in the plant. Stuffing of natural or artificial casings is done under pressure, the empty casing being fitted over a spout after which the operator turns a valve which discharges the ground meat into the casing until filled. A skilled operator is required because very accurate control of this pressure is necessary. Some high quality sausage is packed in natural casings. So-called skinless frankfurters are packed in artificial casings, which are removed after smoking.

The sausage linking machine measures the sausage, loops and ties in successive operations. The several operating mechanisms of this machine, which need lubrication, require a high quality light colored grease. Sparing application by pressure gun is best assurance against overlubrication and leakage.

Bacon

Bacon is smoked before it is shaped and sliced. The mechanisms of a slicing machine are quite as intricate and precise as in a sausage linking machine. They are small, precision built and largely involve anti-friction bearings. Bacon is sliced at around 150 to 200 cuts per minute, so the machinery runs at high speed. To protect the bearings, the same type of grease as used on the sausage linking machine is preferred, here, likewise, applied by pressure gun.

TROLLEY WHEELS AND MEAT HOOKS

Meat inspection laws require washing and sterilization of these parts after each usage. Subsequently, relubrication of the trolley wheel pins is necessary.

Washing and sterilization are done by immersion in a vat of hot soda-ash solution or tumbling in a rotating tumbler. Then they are washed or rinsed in hot water. All this develops quite a shine to the surfaces which quickly rust unless the parts are re-oiled.

Choice of the proper material for re-oiling is of concern to all packers. Whatever they use, it must not drip off to stain the meat; otherwise oil or rust spots would have to be cut out involving loss of fat and degrading of the carcass. A high wax content material is most widely used. Some packers immerse their trolley wheels in hot petrolatum. A very effectual non-drip, re-lubrication and rust prevention compound can be made by mixing 25% of paraffine wax with 75% of light paraffine oil. This sets up when cold, sticks to the surfaces, does not drip and gives good pin lubrication.

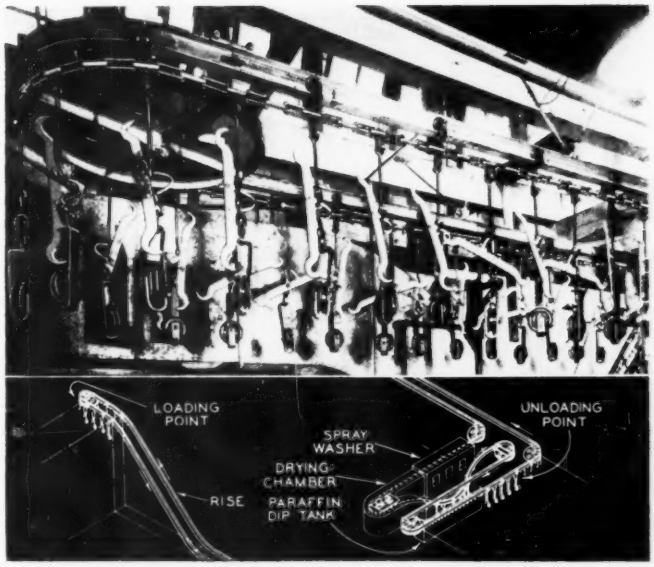
MEAT CONVEYORS

Conveyors share honors with refrigerating machinery as being the most essential equipment in modern handling of meats. In fact the meat packing industry was among the first to use the moving bar chain and overhead trolley for conveying the products being handled. All the way through the plant, conveyors expedite the procedure from the hog sticking conveyor and endless moving chain

conveyor which start with the animals just after killing, down to the overhead trolley rail conveyors which take the muslin cloth-covered sides to the coolers. In between there are the incline conveyors for calves and sheep, the hog cleaning and scalding units, apron conveyors for the scalding tub, beef head conveyors and the larger units which handle carcasses from the decline conveyor to the cutting tables.

As conveyors were improved, production methods and plant schedules were materially expedited. Likewise, as more attention was given to conveyor bearing design, to housing seals and to means of protecting lubrication, so was dependability of the entire conveying system improved.

Study of these factors by conveyor builders and bearing designers was prompted by appreciation of the rough service to which conveyors in meat packing service are so frequently subjected.



Courtesy of Link-Belt Company

Figure 6 — Link-Belt mechanism for automatic handling and cleaning of hog trolleys and gambrel sticks. Handling, cleaning and dipping are done on one unit without transfer or re-handling.

Lubrication and judicious maintenance must be properly carried out for costs of upkeep must be reduced. This also has a relation to power consumption for operation of a conveyor requires power and it is amazing how power consumption will increase if operating conditions are unfavorable and if frictional resistance is allowed to build up.

Friction, of course, can never be eliminated. There must always be some resistance to motion developed between any moving parts regardless of their design. So a certain amount of wear always must be expected between bearing surfaces, rollers, chains, sprockets or gear teeth. If this is allowed to continue, ultimately the conveyor will have to be shut down for repair. This means loss of production. Fortunately, however, friction and excessive wear can be reduced materially by effective lubrication provided, of course, that the parts have been designed for protection of the lubricant in service and for periodic adjustment to compensate for wear.

Features of Design

A considerable variation in conveyor design is applicable to meat handling as already indicated.

The screw conveyor consists essentially of a stamped or rolled steel spiral which is secured by lugs to a shaft or rod. A screw conveyor is used to good advantage in moving stock feed in the tankhouse. The ribbon conveyor in turn consists of a ribbon flight similarly secured to the shaft or rod with an open space between the ribbon and the shaft.

The screw conveyor is designed normally for horizontal or incline movement of comparatively dry materials in contrast with the ribbon conveyor which is capable of handling damp or sticky materials which would otherwise build up around the shaft of a solid flight screw conveyor.

The scraper or flight conveyor is also of interest. It functions by dragging the product along a trough by means of flights which are usually made of wood. A scraper conveyor can be used in either horizontal or inclined service. It is built with either a single or double chain to which are bolted the flights or scrapers.

Where incline or decline conveying is to be done the bucket type of conveyor is widely used. This involves the use of bucket-shaped scoops which take the place of flight or apron blades. The buckets differ in design according to the type of product to be handled. The principles of operation, however, are essentially the same.

Bucket conveyors will handle practically any material which will not adhere to the containers. These latter are carried between a pair of roller chains, or a strand of chain or in some installations on a belt. They may be located either vertically or on an incline and have continuous or non-continuous buckets. The discharge or intake of any such container will obviously depend upon the locality and the product to be handled.

In addition to the above types of conveying equipment, there is also the apron conveyor. This unit is capable of handling any material which will

not adhere to the carrying surface or leak through any part of the conveying medium. Such a conveyor is made up of two sets of roller chains separated by over-lapping apron plates which form the carrying surface. The chains are driven on sprockets at one end — take-ups being provided at the other end. This conveyor pulls the material toward the driving end at which point one must also provide for discharge.

The belt conveyor is also applicable to some phases of meat packing service. A belt conveyor involves an endless belt of fabric which is designed to travel over pulleys at the conveyor ends and over idlers located at suitable intervals between each end of the unit. This type of conveyor will handle any material in bulk which will not adhere to it and which can be fed automatically. It is also well suited for handling of packaged goods. The belt conveyor can be used in service where lubrication of certain of the parts might otherwise become contaminated as its conveyor and idler rollers operate on anti-friction bearings which have been very carefully designed to enable protected lubrication. Application of lubricants is, therefore, only necessary at infrequent intervals provided a specially prepared anti-friction bearing grease is used.

Lubrication

Conveyor bearings are lubricated according to the means for lubrication available. Sleeve bearing at the ends of a screw conveyor can be pressure grease cup lubricated to good advantage. Roller conveyors usually have pressure gun fittings installed.

Cooler and dressing floor conveyor mechanisms require very careful attention. They go from hot room to coolers and are subject to quite a temperature drop, i.e., from around 80° to 34° F. A lubricant for such service must not drip at 80° nor set up too hard at 34°. In other words, good adhesiveness is requisite. These desired characteristics are obtained by the petroleum chemist by compounding light grease with a special agent which gives both water resistance and increased adhesive properties.

ELEVATORS

Elevators are another important item of packing house equipment which requires lubrication. Electric elevators predominate. Their operating mechanisms involve motor bearings and sheave bearings.

Construction of the bearings determines the manner of lubrication. Sleeve-type bearings built for chain or ring oilers require a good grade of engine oil having a viscosity of from 300 to 500 seconds Saybolt Universal at 100 degrees Fahr. Ball or roller bearings require a lubricant specially prepared to meet the load conditions, prevent corrosion and resist oxidation.

The lubricant for elevator worm gears should be of sufficient body to withstand the pressures which prevail at the points of tooth contact since it must protect the bearings and gear tooth surfaces against wear as well as pitting or corrosion. The pour test should be sufficiently low to enable the oil to be used in cold localities. The level at which the lubricant is carried in a worm gear case is particularly important. Normally this level should be no higher than the center of the worm shaft in the conventional drive where the worm is located below the gear.

Cables of so-called wire rope type are periodically lubricated with a special wire rope lubricant which is so prepared that it will be able to penetrate between the metallic strands, resist drip and function over a considerably wide range of atmospheric temperatures without hardening when cold, or flowing off when warm.

ELECTRIC INDUSTRIAL TRUCKS AND TRACTORS

Keeping meat moving where conveyors are not available is accomplished by electric industrial trucks and tractors. The truck carries its own load directly; the tractor is a self-propelled vehicle which is used for pushing or pulling other conveyances which carry the load. Lubrication of the electric or storage battery vehicle requires protection of the motor bearings, driving gears, elevating gears (where installed) and the chassis parts which include wheel bearings, universals, the steering gear and brake parts.

The final drive includes only the differentials at the rear axle. An automotive type of gear lubricant within the S.A.E. 90 or 140 grade is generally preferred.

Grease is used on the drive and trailing wheel bearings, a grease specifically designed for wheel bearings being preferred. The same type of grease is also sometimes applicable to the universals. Resistance to squeezing out is important on these parts.

Motor bearings, steering elements and other parts can be well lubricated with a mixed base ball or roller bearing grease or a 500 second viscosity straight mineral oil where oil is required.

BEARING LUBRICANTS

The requirements which must be considered when selecting bearing lubricants for conveyors, motors and fans are of interest. As the machinery is handling perishable materials which may have their value ruined by oil or grease drip — this requires careful consideration. That is why modern designs of anti-friction bearings especially, provide

for positive retention of lubricants. It is only necessary to use the lubricants intelligently, assuming that they have been selected in accordance with the operating conditions and methods of lubrication.

The pressure gun and compression grease cup are mainly used for servicing grease-lubricated bearings in the packing plant. A pressure gun should be used with care. On the bearings employed in conveyors, motors or sausage linking or bacon cutting machinery the capacity for grease is usually very low — oftentimes, less than an ounce is necessary; furthermore, any such bearing should never be filled full of grease. About half-full is best.

Constant pressure on the lubricant is only necessary when dealing with plain or sleeve type bearings. Here compression grease cups are used. Constant pressure applied to a ball or roller bearing will cause over-charging and seal leakage. Furthermore, additional power would be required to turn the bearing due to resistence of the grease to churning.

Grease Stability

Lubricating greases for such systems must be carefully selected. A few words as to greases should be of particular interest as they are depended upon so widely in this industry for bearing protection; furthermore, the meat packer supplies the necessary fats.

The petroleum chemist has done a masterful job in developing grease formulae and manufacturing procedures which produce greases of marked stability. The extent to which animal fats are used is particularly interesting.

Stability is most important, for a charge of grease on any intricate mechanism must function dependably for a considerable period of time. Some ball bearing motors can go for several months without need for re-lubrication.

Stability indicates to the chemist that the grease will be resistant to separation or oxidation. Leakage and soap deposits would be an indication that separation has occurred. Oxidation may cause gumming and varnish-like deposits.

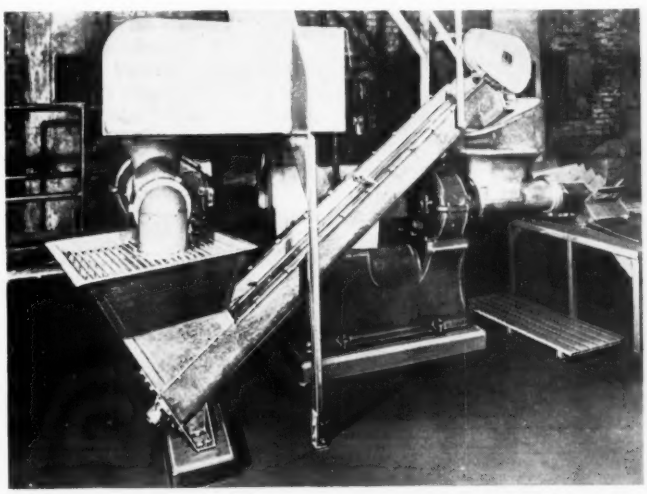
Lubricating Ability in the Presence of Moisture

As water washing must be widely practiced in all packing plants, for sanitation purposes, the possibility of moisture-contamination of lubricants is of importance. In this consideration it is necessary to include gears and chains as well as the bearings. Wherever continued exposure to or contact with moisture may prevail, the lubricant should be able to emulsify with water to some extent. In this way a lubricating film is formed which will be resistant to the washing action of water.

Emulsification is promoted by compounding straight mineral oils with a small amount of animal or vegetable oil. In other words when certain of these latter (termed fixed oils) or some types of soaps are added to a mineral oil, if the subsequent compound is mixed and agitated with water the resultant emulsion of the two liquids will separate very slowly or even stay in an emulsified state indefinitely. Emulsification is essentially a physical reaction, but a very necessary one wherever lubrication under wet conditions is necessary.

Some sodium soap greases behave in a similar manner. Emulsions are usually quite tenacious or sticky. On the other hand they may not be very stable chemically in which case they may become corrosive due to increased acidity. Then there is likelihood that the emulsion in question may become actually gummy due to oxidation. This can be retarded however if the lubricant has been carefully refined to insure removal of unstable hydro-carbon components which are most easily oxidized. The machine operator can help by observing regular and frequent periods of renewal of lubricants, and establishing a cleaning schedule.

The relation which acidity bears to emulsification and sludge formation has formed the basis for considerable study due to the extreme complexity of acid-forming constituents such as sulfur and oxygen and the limited knowledge of their reactional tendencies.



Courtesy of Link-Belt Company

Figure 7 — Link-Belt screw conveyor handling meat products. Sanitary, dirt and moisture-proof handling of sausage meat from grinders to mixers is especially important.

Were these reactions more clearly identified or could petroleum oils be refined so as to entirely remove or neutralize their organic acid-forming constituents, the problem of corrosion might be materially simplified. Until this objective is attained, efforts can only be made to render such oils as chemically stable as possible, especially when they are to be exposed to moisture and oxidizing conditions in the lubrication of meat packing machinery.

Saponification a Factor in Grease Making

In contrast with emulsification, saponification is a chemical reaction which has to do with the production of soaps by treatment of a fatty oil with certain types of alkaline solutions. It is one of the essential steps in grease making.

One of the distinctive differences between fixed or fatty oils and petroleum oils involves the ability of the former to undergo a simple chemical reaction whereby the original compounds are split up and their elements re-combined chemically with certain alkalis. When the larger portion of the fatty oil molecules are combined with a metal such as sodium, calcium or aluminum, a soap adaptable to grease making is formed by this phenomenon of saponification.

The petroleum chemist prepares these soaps so that they will resist the disassociating effect of water, or will emulsify according to intended service. Then, he carefully selects his mineral oil constituent and plans a method of procedure which will give a high temperature grease, a water-resistant product or one of fibrous nature. All according to the basic materials, the temperatures involved in mixing, the rate of mixing and whether the finished grease is poured hot or cold.

The lubricating engineer recommends these greases in the packing plant according to the operations to be served. On ball bearings he would use a soda-lime base product of high chemical stability, to protect against bearing corrosion as far as possible. Where he desires a grease which will not dissolve in the presence of moisture, he would use a lime soap grease. Definition of these terms is advisable for the benefit of those who must select and use such greases.

Lime Base Greases

These are made by compounding lime (calcium) soap with a mineral oil of varying viscosity according to the prospective duty. They are smooth, yellow to amber in color and of a buttery texture. By preparing them so that they are entirely dehydrated they can be used at operating temperatures somewhat above the boiling point of water.

Sodium Base Greases

Soda soaps produce a grease of long fibre especially when compounded with heavy bodied oils within the SAE 80 to 250 range. Such lubricants can be used at temperatures occasionally approaching 400° F. The structural nature of a sodium soap grease plus the natural adhesiveness enables it to resist working out of bearing clearances, where a buttery type grease quickly would work out.

Mixed Base: Sodium — Lime

Greases prepared from sodium and lime soap combine the desirable characteristics of both soaps, and are widely used for ball and roller bearings on packing house motors, and other machines where stability and dependability are required. Mixed base greases do not oxidize readily, hence they are dependable lubricants for precision mechanisms.

CONCLUSION

Machinery operators today are becoming more and more lubrication conscious. Some of them have had to learn the value of lubrication the hard way — by experiencing the headaches and worries when worn parts could not be readily replaced. Others learned by considering their machines: By studying the design of the moving parts and the lubrication requirements of these parts under the particular operating conditions in their plants. Packing house engineers were largely of this latter group. Evidence that their foresight is paying off is the multitude of machinery they are operating successfully today. They realize the value of controlled lubrication.

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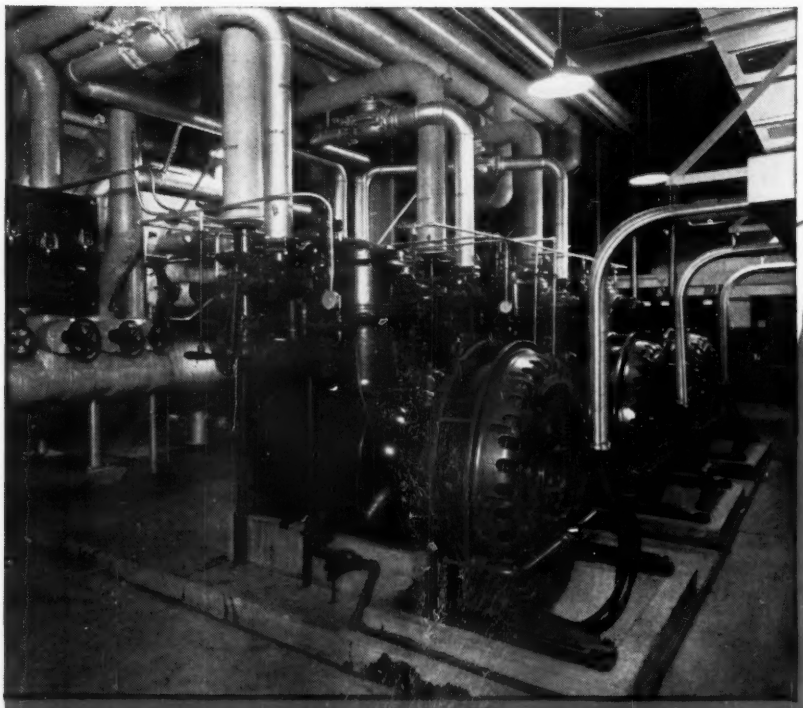

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